A collage of transportation-related images. In the top left, a cyclist is riding on a path with a 'BIKE' marking on the ground, and a pedestrian is walking nearby. In the top right, a white VTA bus with the number 1021 and 'VTA' on its destination sign is shown. In the bottom left, a white VTA light rail train with the number 906 is visible. In the bottom right, a multi-lane highway with several cars and a truck is shown. The entire image has a semi-transparent green and yellow overlay.

California Air Resources Board
January 27, 2006
El Monte, CA

VTA-SAMTRANS ZEB
Demonstration Program



GENERAL DESCRIPTION OF VTA/SAMTRANS PROGRAM

- CARB Requirements
 - Emission Reductions
 - ZEB Starting in 2008/2010
 - ZEB Demonstration Program
- Partnership with SAMTRANS
- Operate Three Fuel Cell Buses in Revenue Service
- Operate Supporting Infrastructure
- Evaluate Feasibility of Fuel Cell Buses
- Estimated Total Program Cost \$18,450,000



DEMONSTRATION PROGRAM

- What is the status of fuel cell technology
- What are the issues and obstacles that need to be overcome
- What improvements could be made
- Community outreach and education



PROGRAM PARTNERS

- SAMTRANS – Partner and Funding
- GILLIG CORP – Bus Manufacturer
- BALLARD – Fuel Cell Manufacturer
- APCI – Fuel and Fueling Facility Supplier
- FTA – Funding
- CEC – Funding
- BAAQMD – Funding
- CaFCP – Support
- CARB – Support and Regulations
- DOE/NREL – Evaluation Support



PROGRAM TO DATE

- Dec 2000 – VTA made commitment to Fuel Cell Bus Demonstration
- Jul 2001 – VTA was accepted as Associate Member of CaFCP
- Jul 2001 – Issued RFP for Fuel Cell Buses
- Jan 2002 – Issued RFP for Fueling Facility
- Jun 2002 – Award contract to the Gillig Corp for 3 buses
- Sep 2002 – Award contract to Air Products CI for fueling facility



PROGRAM TO DATE (cont'd)

- Apr 2003 – First Fuel Cell Bus on assembly line at Gillig Corp
- Sep 2003 – Began Construction of Maint Facilities & Fueling Facility Pad
- May 2004 – Fueling Facility Ready for Commissioning
- May 2004 – Delivery of First Fuel Cell Bus
- Aug 2004 – Delivery of Two Fuel Cell Buses
- Feb 2005 – Begin Revenue Service



SAFETY

- VTA Employees
- Passengers
- Public
- Contractors
- Others
- Safety Review Process (Linda Meadow and Associates)
 - Detail look at each safety requirement (Safety Certification Process)
 - FMEA (Failure Mode and Effect Analysis)
 - Hazard Analysis



BUSES



BUSES

- Bus Manufacturer-Gillig
- Low Floor Model
 - Length - 40 feet
 - Width – 102 Inches
 - Height – 144 inches
 - Wheelbase – 284 inches
 - GVW – 40,600 lbs
 - Seating capacity – 37
 - AC – Thermo King with rotary compressor
 - Ramp Lift –U
- Fuel Cell - Ballard P5-2 300 Kw
- Traction Motor Reuland Electric
 - Model DC-55-13517F
 - Max torque 790 lbs.ft
 - Peak Power Output 225 Kw
 - Rated Speed 2100 rpm
 - Voltage 575 V

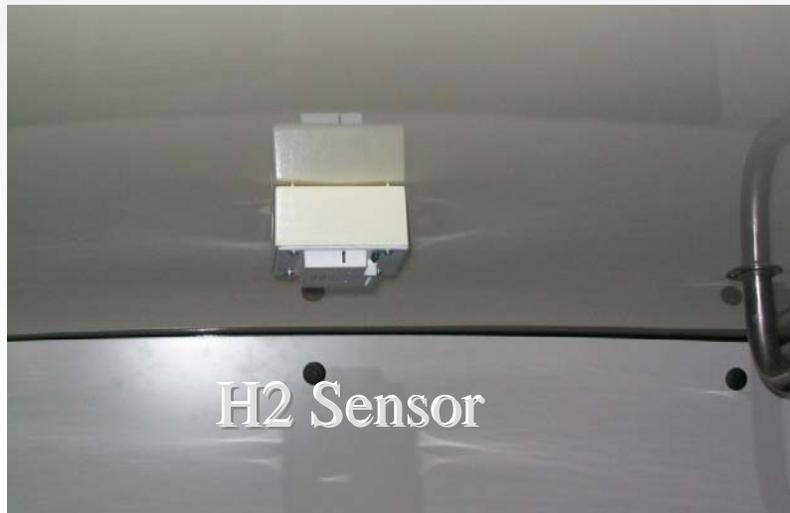


- Transmission - ZF model 6HP592
 - Automatic 6 speed with integral retarder
- Fuel System
 - Gaseous H₂ – 350 barr
 - Dynetek tanks
 - Dynecell Carbon Fiber
 - fueling CaFCP I/O
- Fire Detection system



OTHER SYSTEMS

- Control Systems
- Safety Systems
 - Crash Sensors
 - Hydrogen Sensors
 - Flame Sensors



FACILITIES

- Hydrogen Fueling Facility
- Maintenance Facility
- Supporting Facilities



HYDROGEN FUELING FACILITY

- Leased facility from APCI
- Liquid hydrogen delivery and storage
- Compressed to 6000 psi and vaporized for storage in cascade
- Similar to facility at Ca FCP
- Bus fueling capability goal of 8 minute fill with communications



FACILITY MONITORING

- APCI Telemetry
- Sensors
- Alarms
- RFI
- Remote Emergency Stop



Flame Sensors



Dispenser w/EStop



MAINTENANCE BAYS

- Fire Marshall

- Bay area limited to two buses
- Separation include major fire wall requirements
- Ventilation system for complete ventilation.
- No air pockets in ceiling
- Hydrogen detection system
 - Internal and external monitoring
- Flame detection system
- Alarms
- Class 1 Div 2 Electrical classification in complete facility
 - Ceiling lighting
 - Fans
 - Fixtures
 - Electrical outlets
 - Heating system
 - Etc.
- Doors



MAINTENANCE BAYS

- Cannot have both hydrogen and diesel bus in facility at the same time
- No open sparks, grinding or welding.
- Sprinklers
- Systems operation
 - Detection at 15% LFL and 50% LFL
 - Doors
 - Fans
 - Electrical
- Operating procedures
- Safety and emergency procedures



SUPPORTING FACILITIES

- Vault area to be hydrogen safe
- Bus wash designed for hydrogen safety
- Other buildings that bus would need to access need to be designed for hydrogen safety.
- Requirement to fully purge bus of fuel for over haul and repair



TRAINING

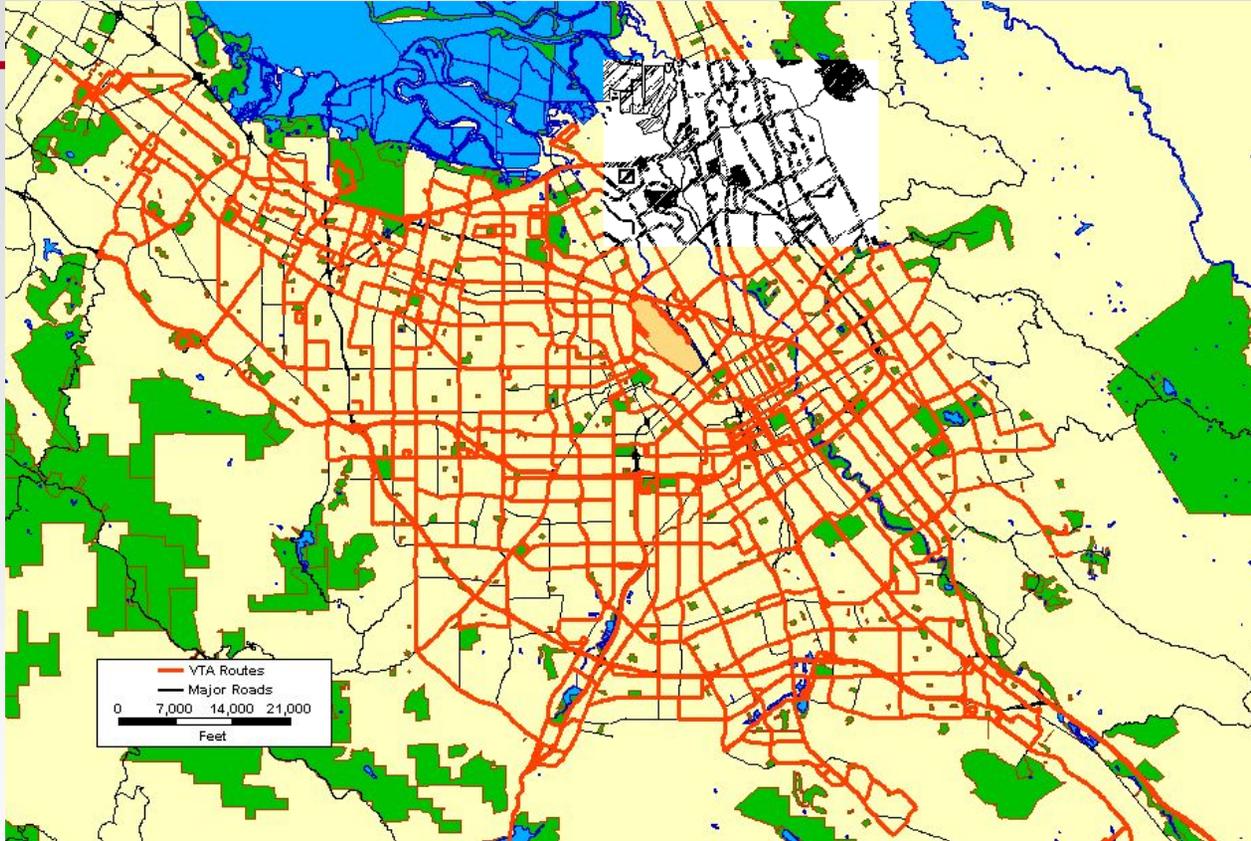
- Bus Operators
- Bus Technicians/Mechanics
- Cleaners
- General Personnel
- Operations Control Center
- Facility Maintenance Personnel
- Emergency Response (VTA)
- Emergency Responders



EMERGENCY RESPONDER TRAINING



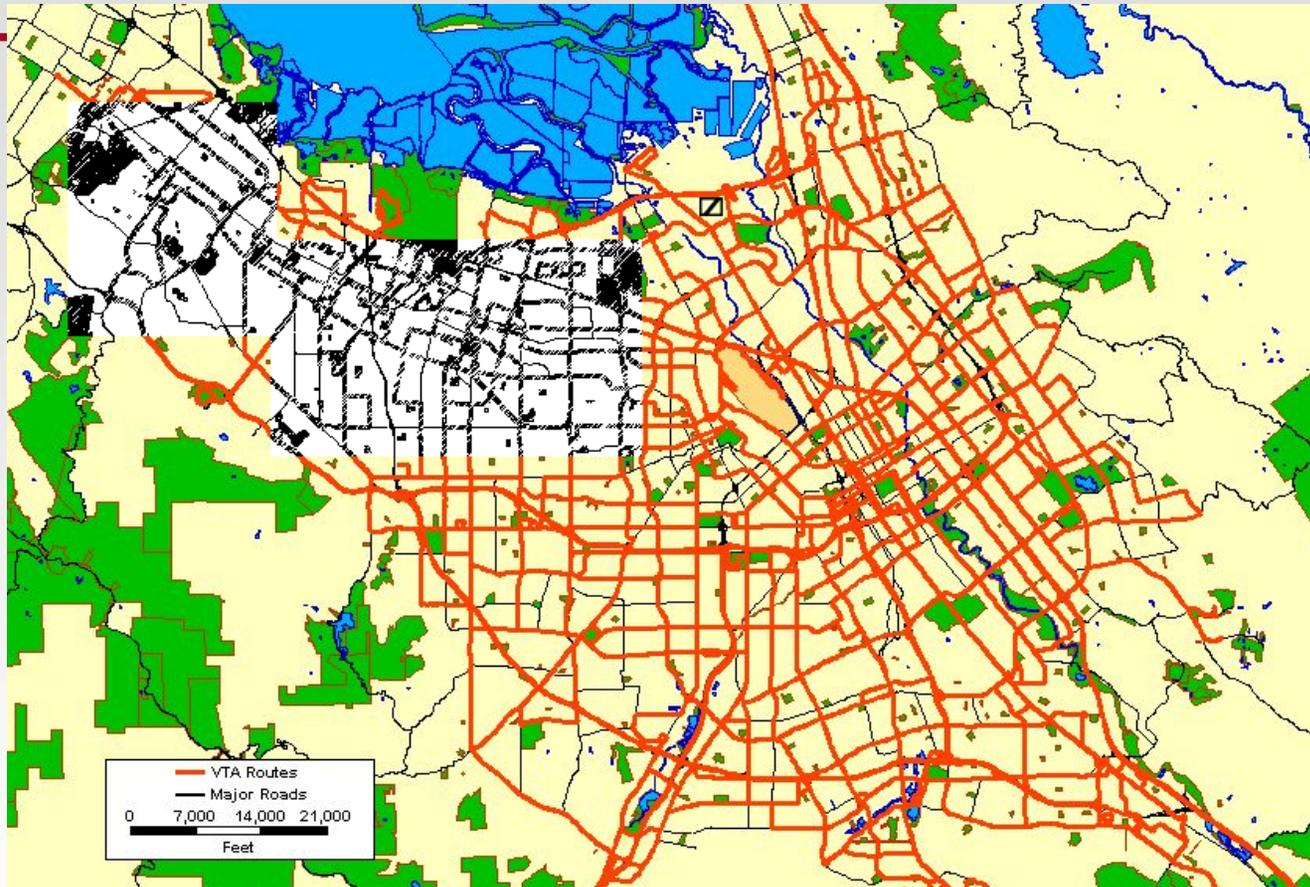
VTA REVENUE SERVICE



- Started revenue service on routes 33, 45, 46 and 47.
- Near operating facility for expedient response.



VTA REVENUE SERVICE



- Next routes include 32 and 53 lines.
- Then continued with routes across the county including 22, 63, 71, 102 and 104.



COMMUNITY OUTREACH



Santa Clara County Science Fair
San Jose Convention Center



San Jose State University
Earth Day



COMMUNITY OUTREACH

- February Kick-Off Event
- Santa Clara County Science Fair
- SJSU Earth Day
- Historic Bus Society
- Northern California Fire Prevention Officers
 - Hazmat Sub-Committee
- Delegations from Japan
- Delegation from Europe including Finland
- KPIX Television Ch 5 News
- KGO Television Ch 7 News
- Various Newspapers and Magazines
- VTA.ORG
- World Environment Day
- CaFCP Road Rally
- Schools



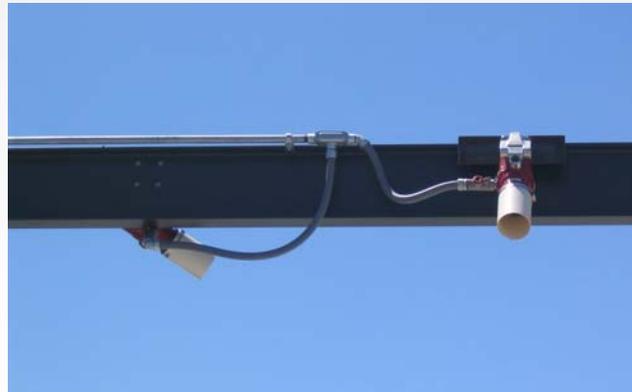
CHALLENGES

- Fueling Facility
- Bus
- Maintenance Facility
- Supporting Facilities



FUELING FACILITY ISSUES AND INCIDENTS

- Early designs
 - Still working with prototype systems
 - New pump designs
 - New flame detectors
- Proprietary issues
 - System understanding
 - Monitoring systems
- Transit application
 - Not familiar with transit requirements
 - Fueling occurs only part of the day
 - Facility closed part of the day
- System integration
 - How do systems tie into Transit Agencies systems
 - Alarms
 - Monitoring
 - Safety
- Safety procedures
- Reporting systems
- Response time



FUELING FACILITY ISSUES AND INCIDENTS

- Fuel times
 - Improving but limited for operation
- Hydrogen loss
 - Boil off venting
 - Cooling venting
 - Line venting
 - Fill venting
- Operation
 - Reliability of new system
 - Fuel leaks
- Emergency responders
 - Safety zones
 - Acceptance of concerns
 - Codes and Standards



MAINTENANCE FACILITY ISSUES AND INCIDENTS

- Hydrogen monitoring system installation
 - Initially not Class 1 Div 2
 - Were not ready for remote monitoring
- Schedule delays
 - Familiarity with hydrogen
 - Lack of regulations, codes and standards
- H₂ monitoring failures
 - Require to calibrate sensors every 6 months (others every 3 months)
- Component availability
- Facility use



BUS ISSUES

- Weight – Fuel cell system and structure to support systems.
- H2 Sensors – Sensors are sensitive to various chemicals.
- Bus height – (approximately 2 ft higher than VTA standard buses)
- Limited operation
 - Unacceptable areas (i.e. Valco Fashion Plaza)
 - Range limitations in revenue service
 - Operator availability (training and keeping informed)
- PRD hydrogen releases
- Maintenance requirements
 - Daily pre-pull out inspection
 - PMs
 - Daily, hourly, mileage fuel cell, system and bus.
 - Repairs
 - High degree of support required from Ballard
- Parts and materials



ISSUES AND OBSTACLES

- Fear of hydrogen – Hindenburg factor
- Prototype Technology – New and requires support,
- Limited vehicles – parts availability and cost
- Manufacturers and suppliers not familiar with Transit requirements – Operation of facility, bus availability, bus reliability, road call etc.
- Emergency Responders
- Permitting – codes and standards
- Operating in tunnels and other overhanging areas
- Support facilities – Maintenance, fueling, washing
- Maintenance – Cleaning chemicals, tools, general environment



PERFORMANCE TO DATE

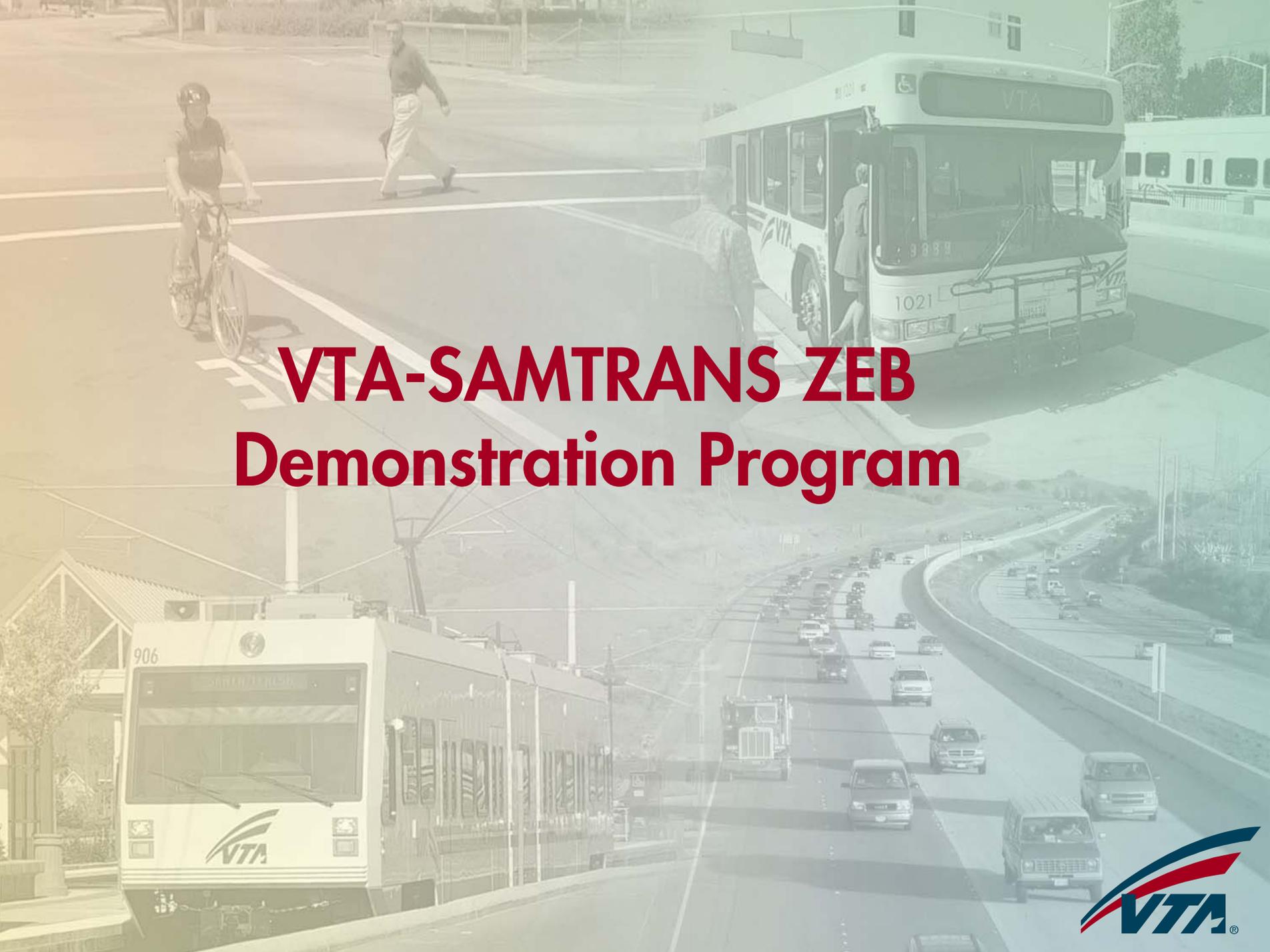
- Maximum speed -
- Reliability -
- Availability –
- Fuel efficiency –
- Range –
- Gradability -
- Acceleration -
- Deceleration -



FUEL FACILITY PERFORMANCE

- Initial performance
 - Fills typically in excess of 20 minutes with some fills over 40 minutes.
 - High level of venting
- Latest changes and improvements
 - Accomplished fills under 10 minutes
 - Anticipate reduced vent loss



A collage of transportation images. In the top left, a cyclist in a helmet and a pedestrian are on a paved path. In the top right, a white VTA bus with the number 1021 and 'VTA' logo is shown with its front door open. In the bottom left, a white VTA tram with the number 906 and 'VTA' logo is shown. In the bottom right, a multi-lane highway with many cars is shown. The entire image has a semi-transparent green overlay.

VTA-SAMTRANS ZEB Demonstration Program

